5. COMPARATIVE ANALYSIS AND RECOMMENDATIONS

This section presents a comparative analysis of the assembled alternatives presented in Section 4 and recommendations for future evaluations to support developing the WAG 7 feasibility study.

5.1 Comparative Analysis of Remedial Alternatives

Following sections provide comparative discussions while briefly assessing advantages and disadvantages of each alternative with respect to the CERCLA screening criteria. A summary of the assessment is provided in Figure 5-1. More details of the comparative screening evaluation are in Appendix C.

5.1.1 Overall Protection of Human Health and the Environment

All assembled alternatives (with the exception of the No Action alternative) would achieve the RAOs. The alternatives would effectively control or eliminate potential exposure pathways, reduce future contaminant releases from the source term, and protect human and ecological receptors. However, all alternatives would leave waste in place within the SDA. Therefore, long-term protectiveness for each alternative depends on the basic premise that DOE or another federal agency would retain control of the site in perpetuity.

In evaluating overall protectiveness, long-term risks and short-term impacts resulting from remediation are considered. As discussed, all action alternatives can satisfy RAOs and provide long-term protectiveness. However, potential short-term impacts could be substantially different. In general, both the Surface Barrier and the ISG alternatives have the shortest implementation period and would have comparably lower potential impacts on both workers and adjacent communities. The Surface Barrier alternative is essentially a standard earthwork operation requiring the least intrusive work. The ISG technology has been extensively researched at the INEEL to provide an approach that minimizes risks to workers and the environment. The two remaining alternatives, ISV and RTD, could have significantly higher short-term impacts in comparison. The ISV concerns involve variability and uncertainty in the nature of buried waste, potential impacts due to emissions from the ISTD and ISV process, and potential melt expulsion events during ISV. Though design measures could be implemented to minimize these potential impacts, additional onsite design testing would be required to adequately address these issues. The RTD alternative requires significant intrusive work that could result in the greatest impacts on workers and the environment. In addition, the RTD alternative includes a significant off-Site transportation component for TRU waste disposal at WIPP. This would result in increased traffic loading and associated impacts within the adjacent communities.

As presented in the previous sections of this PERA, fate and transport modeling indicates that all action alternatives would reduce contaminant migration to groundwater to within acceptable concentrations. However, modeling also indicates potentially significant influences on groundwater quality from contaminants that may have been previously released from the source term to the underlying vadose zone. Impact from this postulated contamination in the vadose zone, in terms of risk to potential future receptors, is presented in Figure 5-2.

	Alternatives				
Criteria	No Action	Surface Barrier	In Situ Grouting	In Situ Vitrification	Retrieval/ Treatment/ Disposal
Overall protection of human health and the environment	• Does not address RAOs • Does not provide for the overall protection of human health and the environment	• Addresses RAOs • Immobilizes and isolates COC bearing wastes through capping • Destroys organic COCs in high concentration waste streams using ISTD • Immobilizes activation/fission product COCs using ISG	• Addresses RAOs • Immobilizes COC bearing wastes using ISG • Destroys organic COCs in high concentration waste streams using ISTD	• Addresses RAOs • Immobilizes and destroys wastes using ISTD/ISV • Immobilizes activation/fission product COCs using ISG	• Addresses RAOs • Removes TRU wastes from site • Non TRU COC bearing waste streams will be retrieved, treated and placed in on-site engineered landfill. • Immobilizes remaining COC wastes using ISG
Compliance with ARARs	• Not compliant	• Potentially compliant	• Potentially compliant	• Potentially compliant	• Potentially compliant
Long term protectiveness and permanence	• Does not provide for long term protectiveness	• Provides long term protectiveness • Long term maintenance required to insure protectiveness	• Provides long term protectiveness • Potentially permanent solution • Long term maintenance required to insure protectiveness	• Provides long term protectiveness • Potentially permanent solution • Long term maintenance required to insure protectiveness	• Provides long term protectiveness • Permanently removes risks associated with TRU wastes • Long term maintenance required to insure protectiveness
Reduction of toxicity mobility and volume through treatment	• Does not reduce source toxicity, mobility, or volume	• ISG treatment reduces contaminant mobility in SVRs and trenches. • ISTD treatment reduces organic COC volumes in high concentration waste streams.	• Reduces contaminant mobility in all COC bearing wastes	• Reduces contaminant mobility, toxicity and volume in all COC bearing wastes	• Removes TRU wastes • Ex situ treatment will reduce toxicity, mobility, and volume of retrieved non-TRU wastes from pits, trenches, and Pad A. • ISG treatment reduces contaminant mobility in SVRs and trenches.
Short term effectiveness	• Lowest worker risk	• Minimal intrusive work requirements	• Contamination control for ISG researched for INEEL specific application	• Contamination control for ISV has not been proven. • Higher potential worker risk	• Extensive intrusive work requirements • Highest risks to workers and off-site communities
Implement-ability	• Easily implemented	• Primary technology (surface barrier) consists of standard earthwork operation.	• Primary technology (ISG) has been researched for SDA specific application.	• Primary technology (ISV) requires specialized equipment.	• Requires complex interaction of remedial activities and technologies with site-specific designs
Costs	Total Cost **\$ 38.5M** Net Present Value **\$ 9.6M**	Total Cost **\$841.6M** Net Present Value **\$616.1M**	Total Cost **\$1,118M** Net Present Value **\$ 822.6M**	Total Cost **\$1,815.3M** Net Present Value **\$1,197.3M**	Total Cost **\$6,889.1M** Net Present Value **\$3,779.7M**

Figure 5-1. Comparative analysis of alternatives.

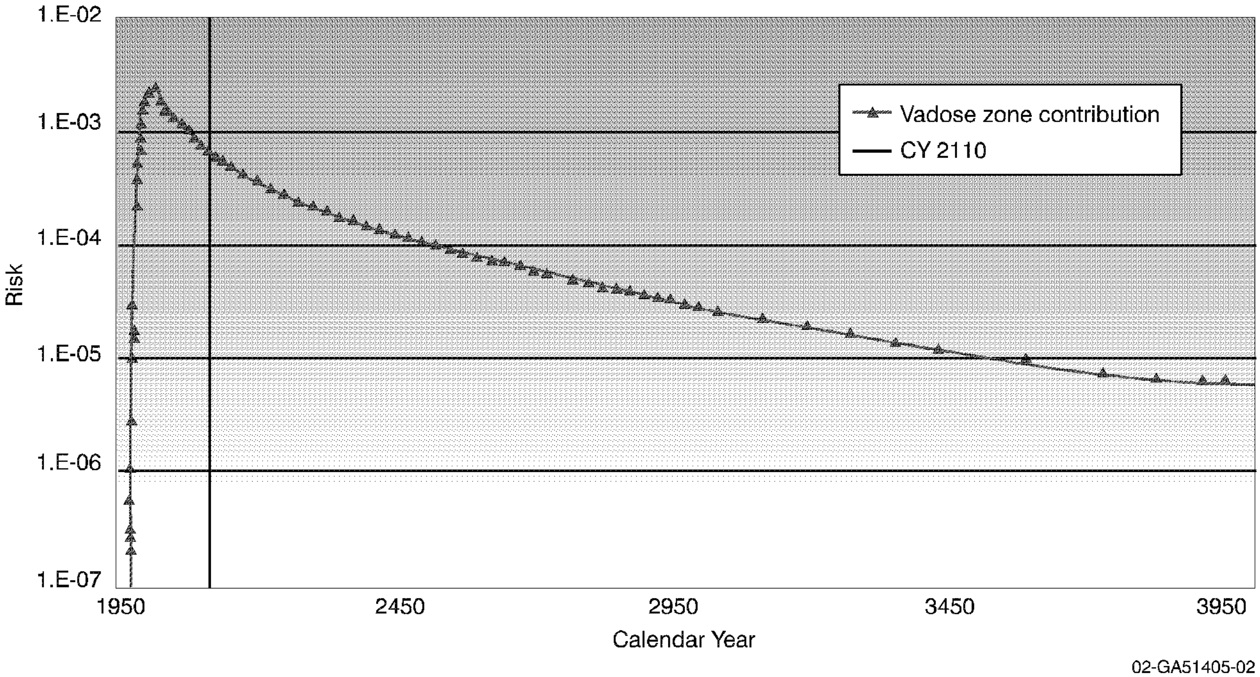

Figure 5-2. Groundwater risk for a hypothetical future residential scenario resulting from postulated contamination in the vadose zone.

Results of the analysis indicate that, regardless of the alternative selected (including RTD), future adverse impacts on the groundwater near the SDA could be realized. As shown in the figure, contaminants within the vadose zone are projected to result in carcinogenic risk exceeding 1E-04 in the underlying groundwater extending for approximately the next 500 years. However, several issues must be considered in interpreting Figure 5-2:

- The plot shows maximum cumulative groundwater ingestion risk associated with postulated contamination in the vadose zone. The simulated receptor location for this maximum risk is generally at the southeast corner of the SDA, where maximum contaminant concentrations are predicted to occur. The region of the aquifer where the maximum estimated risk occurs is not readily accessible to the public because of its location within controlled boundaries of the INEEL. Modeled risk estimates at the INEEL boundary do not exceed 1E-06.

- Peak risk within the INEEL boundary, occurring in approximately 2010, is attributable primarily to C-14, I-129, and Tc-99. Substantial uncertainties are associated with estimated risks and, as discussed in the ABRA, detected concentrations in the environment do not validate the magnitude or timing of the maximum risks. Detected concentrations in the environment are much smaller than simulated concentrations, indicating that the models are not well calibrated. However, C-14, I-129, and Tc-99 have been detected in the environment, and some increasing trends in the monitoring data may be developing. Therefore, the potential vadose zone contamination indicated by the modeling may be developing, but not as quickly as is predicted in the simulations.

- If contaminant release is slower than assumed in the model, risk would spread out over time. Compared to the modeling results, the peak could occur later in time and could take longer to diminish. The magnitude of the peak risk could be less than the currently predicted peak, but could still exceed threshold levels because of the substantial mass of these contaminants in the SDA.

- The magnitude of the potential vadose zone contamination will be affected by the timing of remedial actions. If actions to substantially reduce release of C-14, I-129, and Tc-99 are implemented within the next few years, future impacts to area groundwater could be greatly reduced.

5.1.2 Compliance with Applicable or Relevant and Appropriate Requirements

Compliance with ARARs is addressed by evaluating chemical-, action-, and location-specific factors. A summary of potential ARARs and TBCs is presented in Appendix A. A listing of ARARs, TBCs, and potential compliance issues for each alternative is provided in their respective subsections.

The PERA does not address remediating area groundwater. Therefore, contaminant-specific groundwater standards, such as federal and state drinking water standards, were not identified as ARARs for OU 7-13/14. All action alternatives reduce future releases from the source term to levels that comply with these standards, but do not address potential influences from contaminants that may have already been released to the vadose zone. Fate and transport modeling indicates potentially significant influences on groundwater quality from postulated contamination in the vadose zone.

The INEEL Site Composite Cover used for the Surface Barrier alternative or the Modified RCRA Subtitle C Cap used for the ISG, ISV, and RTD alternatives would effectively isolate waste and contaminated soil and provide compliance with contaminant-specific ARARs associated with air quality and dust emissions from the site.

All action alternatives can be designed to be compliant with the identified location-and action-specific ARARs and TBCs. The location-specific ARARs are essentially identical for all alternatives. To implement any alternative, appropriate study and mitigation measures would be conducted for developing borrow areas. The same would be done for any infringement on areas adjacent to the SDA to address the potential presence of archaeological and historical artifacts. It is assumed that all action-specific ARARs would be met by using appropriate engineering controls.

All action alternatives can achieve the RAOs and provide long-term protection of human health and the environment. Each alternative includes a protective cap with long-term maintenance to preclude biotic intrusion into buried waste and to minimize release of contaminants remaining in the source term. In addition, all alternatives would reduce future contaminant release such that concentrations in the aquifer will not exceed a hazard quotient of 2 or carcinogenic risk greater than 1E-04). Potential impacts of postulated contamination in the vadose zone are not addressed. The relative influence of each alternative on carcinogenic risk associated with groundwater quality is depicted on Figure 5-3.

As shown in the figure, the highest degree of groundwater protectiveness is provided by the ISG, ISV, and RTD alternatives. For these alternatives, groundwater risks associated with future releases from the source term would not exceed 1E-05 anywhere in the aquifer. The Surface Barrier alternative would result in steadily increasing carcinogenic risk levels over time, as contaminants slowly leach from the source term, approaching a 1E-04 level in year 12000. The No Action alternative yields cumulative carcinogenic risk in excess of 1E-03.

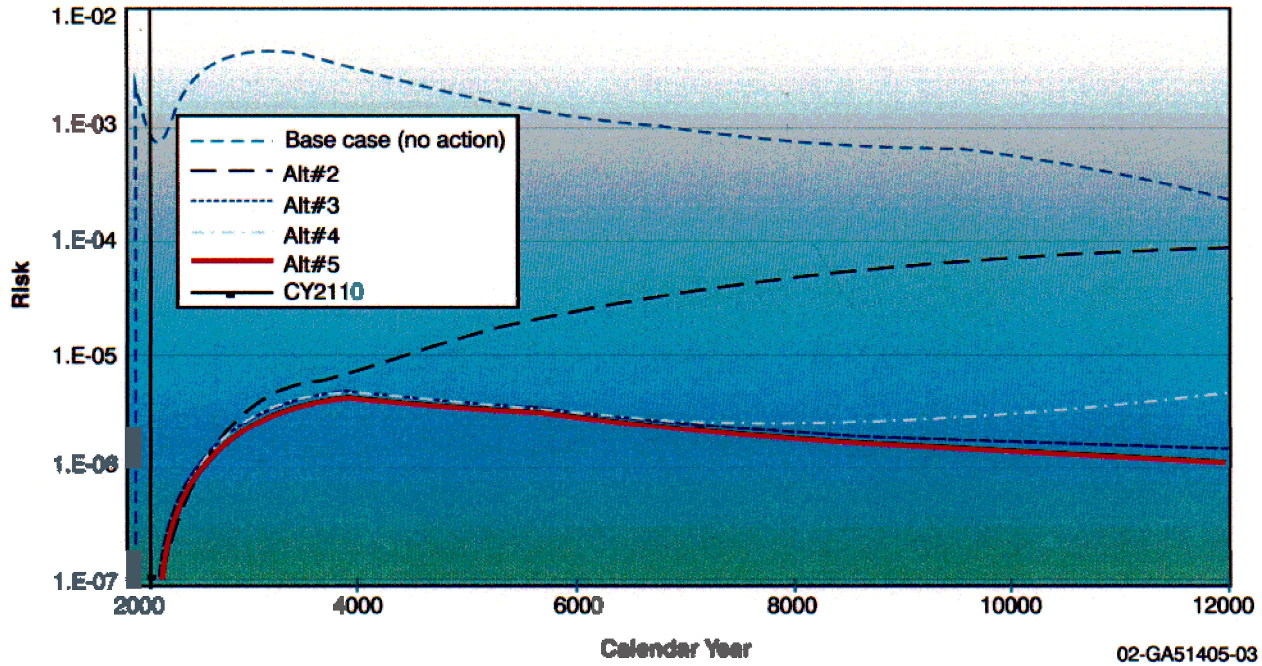

Figure 5-3. Carcinogenic risk in area groundwater for each alternative.

The Surface Barrier alternative would leave significant volumes of untreated waste onsite and thus, of all action alternatives is the least permanent solution. This alternative would require a long-term commitment to maintaining the cap system to ensure conformance with RAOs. Both the ISG and ISV alternatives immobilize contaminants through treatment, while the RTD alternative would reduce mass by removing and treating TRU waste. The ISV and RTD alternatives would reduce the mass of contamination in the SDA and therefore provide a greater degree of permanence than the ISG alternative.

5.1.3 Reduction in Toxicity, Mobility, and Volume through Treatment

The ISV and RTD alternatives would provide the greatest reduction in toxicity, mobility, and volume through treatment. The ISV alternative would destroy organic COCs and encapsulate TRU contaminants in durable glass-like monoliths. The RTD alternative would involve removing the majority of the waste containing TRU COCs from the site. Any retrieved waste returned to the site would be treated for hazardous constituents before disposal. For all the action alternatives (i.e., Surface Barrier, ISG, ISV and RTD), remote-handled waste containing C-14, Tc-99, and I-129 located within some trenches and SVRs would be encapsulated in place using ISG.

The ISG alternative would not significantly reduce the volume or treat the toxicity of the site contaminants. Instead, this alternative reduces contaminant mobility through chemical stabilization and encapsulation. This alternative would include ISTD as a pretreatment in high organic areas within the SDA. Applying this technology would reduce volume and toxicity of VOCs in the source term and thereby would minimize future operational requirements for the existing OCVZ system.

The Surface Barrier alternative primarily relies on placement of a low-permeability cover to reduce mobility of site contaminants. As such, this alternative would not provide for a major reduction of contaminant toxicity, mobility, or volume through treatment. The only exceptions are treating high organic areas with ISTD and treating activation and fission products within the SVRs and trench areas using ISG.

5.1.4 Short-Term Effectiveness

Short-term effectiveness criteria pertain to protecting the community and workers during remediation. An assessment of the potential short-term risks associated with each alternative conducted for this PERA is presented in Schofield (2002). Results of the assessment for each selected alternative are summarized in Figure 5-4.

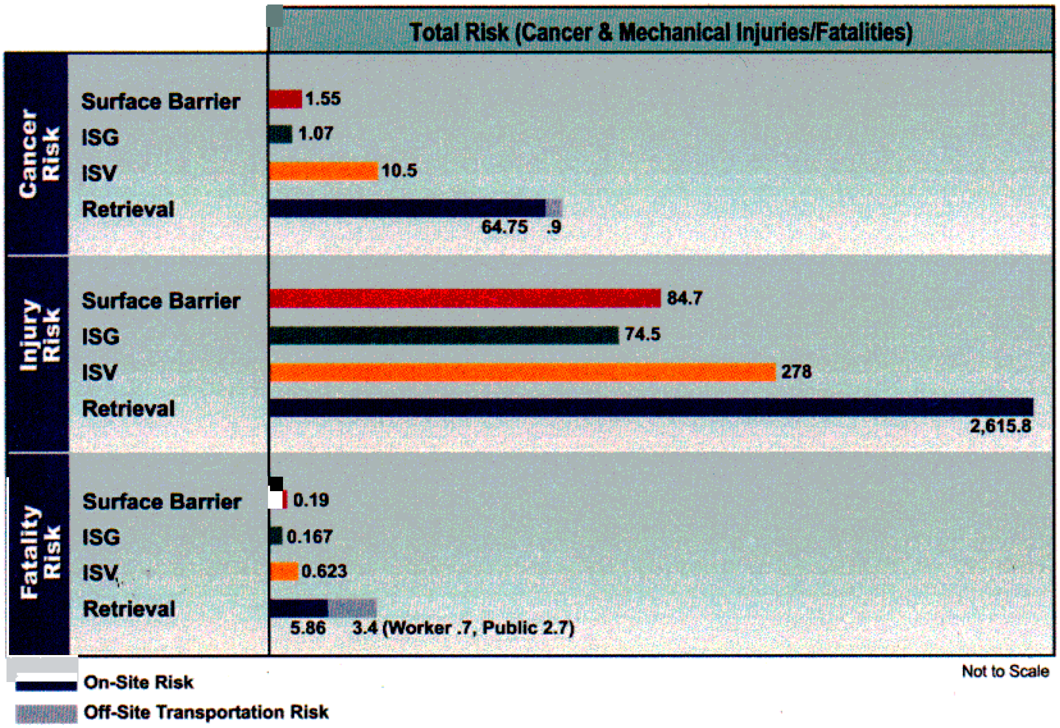

Figure 5-4. Short-term risk summary.

Results are presented separately in terms of the number of latent cancers, mechanical injuries, and fatality risks for each action alternative over the course of its implementation. It is inappropriate to sum all of the risks for an alternative because this would portray a skewed representation of the total risk. The number of mechanical injuries would always be much greater than the number of mechanical fatalities or latent cancers when calculated for the entire schedule of a remedial alternative.

As presented, the RTD alternative would have the greatest short-term risks to workers and the general public. Short-term risks calculated for ISV would be less than those for RTD, but would be greater than those presented for the ISG and Surface Barrier alternatives. The RTD and ISV alternatives would require additional engineering and administrative controls to ensure short-term effectiveness.

For the RTD alternative, potential risks to the public were estimated (see Figure 5-4). Risks to the public are primarily attributable to traffic accidents associated with transport of TRU waste from the SDA to WIPP.

5.1.5 Implementability

The No Action alternative would be the most implementable, requiring no changes in current conditions. This alternative only requires continued operation of existing monitoring networks.

Supplemental remedial technologies are common to all action alternatives. Supplemental technologies include ISG in SVRs and selected trenches to encapsulate activation and fission products, foundation grouting to reduce subsidence potential, retrieval of Pad A, and ISTD in high VOC areas. These technologies are all implementable, but will require additional analysis, design, and testing before they can be deployed.

For the Surface Barrier alternative, designs, materials, equipment, and construction techniques are readily available for constructing the cover.

The ISG alternative is implementable because it has been extensively researched for SDA-specific implementation. An examination of potential interference areas and careful selection of grout types would be and important component of remedial design. A particular concern is stabilizing Pad A waste that contains high concentrations of nitrates. Special equipment and procedures would have to be implemented to ensure worker safety for all intrusive technologies implemented at the SDA. However, compared to other intrusive treatment and retrieval actions, Pad A retrieval would pose the fewest difficulties.

The ISV alternative is less implementable than either the Surface Barrier or the ISG alternatives. Though ISV can adequately treat TRU waste and produce a highly durable and leach-resistant waste form, design uncertainties regarding safety requirements, off-gas treatment, and interference from various waste forms substantially reduce implementability of this alternative. New ISV designs, in particular the planar ISV technology, could effectively mitigate many traditional hazards. but planar ISV has not been sufficiently demonstrated on the variety and type of waste found in the SDA. Extensive analysis, design, and testing would be required before ISV could be implemented on the full-scale required at the SDA.

Implementing RTD would require the complex interaction of several remedial activities requiring site-specific design. The basic activities involving retrieving, repackaging, and safely storing RFP TRU waste streams are potentially implementable and have been demonstrated in varying degrees at other DOE facilities.

5.1.6 Cost

Cost comparisons for the alternatives are presented in Figure 5-5. As shown, the RTD alternative has the highest cost, at a projected net present worth of $3,780 million ($6,889 million, in total FY 2002 dollars). The RTD costs have a high degree of uncertainty because of radiological, chemical, and physical variability of the SDA waste. This variability could affect performance of specific technologies and result in significant impacts on productivity rates.

The next highest cost is for ISV and its net present value is estimated at $1,197 million with a total FY 02-dollar cost of approximately $1,815 million. This is considerably higher than costs estimated for the other in situ treatment alternative, ISG, that is estimated to have a net present value of $823 million and a total FY 02 dollar cost of $1,118 million.

The lowest cost alternative, with the exception of the No Action alternative, is the Surface Barrier alternative. The projected net present value for the Surface Barrier alternative is $616 million and the total FY 02-dollar cost is $842 million.

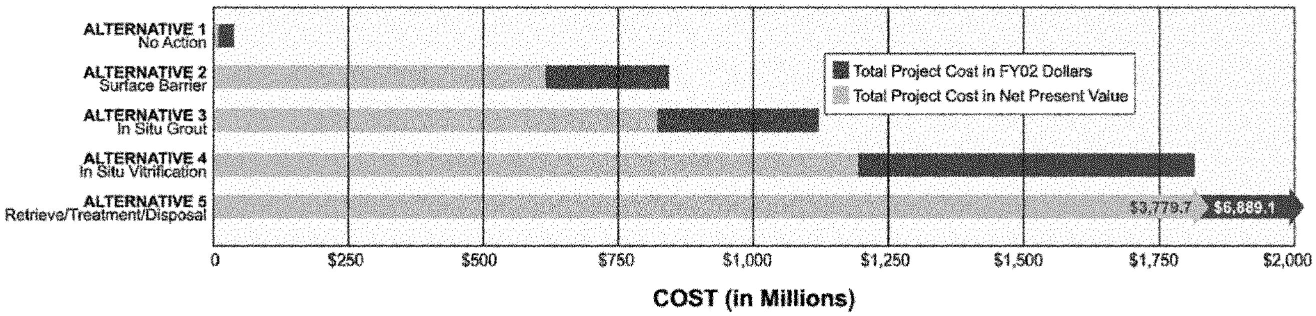

Figure 5-5. Cost summary.

5.2 Recommendations

This section provides a summary of proposed studies for developing the future WAG 7 feasibility study. Initial development of the feasibility study has been completed in this PERA, which provides RAOs, GRAs, technology and process option screening, and assembly of alternatives. The focus of the future feasibility study effort will be to refine and update the detailed analysis of alternatives presented in Section 4 and substantially expand the comparative analysis of assembled alternatives. Recommended areas of refinement include the following:

- Improve precision in descriptions of waste areas and volumes that require remediation using data from probing and probehole monitoring, waste inventory updates, and updates to WasteOScope

- Identify, quantify, and assess alternatives for special-case waste streams that could impede remediation, such as irradiated fuel materials and beryllium reflector blocks.

- Refine evaluation of long-term effectiveness and permanence, and reduction of mobility, toxicity, and volume through treatment using results from bench-scale tests; in particular enhance the ISTD effectiveness evaluation

- Refine waste form parameters for the feasibility study risk assessment modeling using results from the bench-scale and updated information from scientific literature

- Examine in-depth technical and administrative issues associated with implementing alternatives using results of safety and hazard assessments, and revise the short-term effectiveness and implementability evaluations accordingly

- Further define the WIPP waste acceptance criteria and process as the would apply to the RTD alternative and define procedures for characterizing and packaging the waste

- Review assumptions to cost estimates, verify assumptions that could have substantial impact on cost estimates (e.g., availability of borrow sources) and revise estimates.

To address these issues, the feasibility study should incorporate information available from waste inventory and waste zone mapping updates, probing and probehole monitoring, environmental monitoring, information from the OU 7-10 Glovebox Excavator Method Project, and any other source of information that becomes available.

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